Sandia National Laboratories

Energy, Climate, & Infrastructure Security

Scaled Wind Farm Technology Facility

The Scaled WInd Farm Technology (SWIFT) Facility, hosted at Texas Tech University, enables rapid, cost-efficient testing and development of transformative wind energy technology.

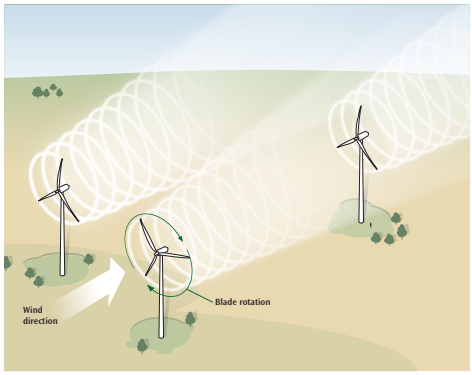

Figure 1.Turbine–turbine interaction schematic with wakes denoted by white helices and white fog.

Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems.

SWIFT performs accredited research testing for both collaborative and highly proprietary projects with industrial, governmental, and academic partners.

A flexible Memorandum of Understanding (MOU), signed by all four partners — Sandia, Vestas, Texas Tech University Wind Science and Engineering (WiSE) Center at Reese Technology Center and Group NIRE, a renewable energy development company — allows use of the site for collaborative and proprietary research, depending on research needs.

SWIFT's primary objectives will be to further research to:

- reduce power loss and damage caused by turbine–turbine interaction shown in Figure 1,
- enhance energy capture and damage-mitigation potential of advanced rotors, and
- improve the validity of aerodynamic, aero-elastic and aero-acoustic simulations used to develop innovative technologies.

Test-Bed Wind Turbines Allow Facility Flexibility While Providing Reliable Data in Many Regimes

SWIFT will initially consist of three research-scale wind turbines (heavily modified V27s) with the first two turbines spaced three diameters apart, perpendicular to the oncoming wind, and the third turbine five diameters downwind (the turbines form a three-, five-, six-diameter-length triangle)

Two turbines are funded by the DOE's Office of Energy Efficiency and Renewable Energy.

The third turbine is being installed by Vestas R&D of Houston, Texas. Vestas invested in the site to develop a technology accelerator to rapidly and cost-effectively facilitate marketplace innovation. Vestas is also interested in improving wind plant performance, rather than concentrating on a single turbine's output.

The V27 turbine was chosen as the test bed due to its proven history of high reliability. It will be capable of full variable-speed variable-pitch operation with rotational speeds ranging from 0 to 55 rpm, rotor blades of 9 to 15 meter lengths, and a maximum power rating of 300 kW.

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These research-scale machines have a Reynolds Number of 2×10^6 and maximum tip-speeds of 80 meters per second which is intended to make the results directly scalable to much larger turbines. In comparison to larger production turbines, at the research-scale, blades and molds are approximately five percent of the cost, cranes are two percent of the cost, crane scheduling is reduced from months-ahead to days-ahead, and failure risk is substantially less.

The site has the potential to add seven additional research-scale wind turbines in the future.

Full Instrumentation for Detailed Data Acquisition

The turbines are instrumented with state-of-the-art control and data-acquisition systems featuring site-wide time synchronization based on GPS.

The site instrumentation will provide hundreds of channels of structural and aerodynamic data to fully estimate the instantaneous state of the rotor, wind turbines, and wind farm for advanced control strategies, such as rotor-based active aerodynamic load control.

In addition, two 60-meter anemometer towers will be located two and one half rotor diameters directly upwind of the leading turbines that will have research-grade three-dimensional sonic anemometers to measure the inflow at six levels, including one that is a blade length above the rotor and a companion set of three certification quality cup anemometers to meet future IEC standards.

WISE Advantages

SWIFT also uses the state-of-the-art atmospheric observation facility at Texas Tech University's Wind Science and Engineering Research Center (WiSE), including the 67-station West Texas Mesonet, a regional SOnic Detection and Ranging (SODAR) network, and the TTUKa mobile research laboratory.

TEXAS TECH UNIVERSITY

Additional facilities at the site include the Texas Tech University 200 meter anemometer tower, a control building that includes temporary office space for proprietary research, and an assembly building with approximately 6,000 square feet of high-bay work space for experimental preparation, as shown in Figure 2.

Figure 2. Repurposed assembly building (top), and a new SWIFT control building (bottom).

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